JC490 U.S. PTO
03/19/99

A

Atty. Docket No. 22074661-25541

JC542 U.S. PTO
09/273149
03/19/99

THE ASSISTANT COMMISSIONER FOR PATENTS
Washington, D.C. 20231
Sir:

Transmitted herewith for filing is the patent application of Inventor(s) **Kevin M. Pintar and Donald L. Bolen**

Entitled: **SYSTEM FOR GENERATING OPTIMIZED COMPUTER DATA FIELD CONVERSION ROUTINES**

Enclosed are:

- ☑ 16 sheets of specification and 15 sheet(s) of drawing(s).
- ☑ An Assignment of the invention to Platinum technology IP, inc. and an Assignment Recordation cover sheet.
- ☐ A certified copy of a priority application.
- ☐ A verified statement to establish small entity status under 37 C.F.R. §§ 1.9 and 1.27.
- ☑ An executed declaration/power of attorney.
- ☐ An Information Disclosure Statement and form PTO-1449.
- ☐ Other

The filing fee has been calculated as shown below:

	(Col. 1)	(Col. 2)		SMALL	ENTITY		OTHER THAN A SMALL ENTITY	
FOR:	NO. FILED	NO. EXTRA		RATE	FEE		RATE	FEE
BASIC FEE					$380	OR		$760
TOTAL CLAIMS	20- 20 =	* 0		x 9	$	OR	x 18	$ 0
INDEP CLAIMS	3- 3 =	* 0		x 39	$	OR	x 78	$ 0
MULTIPLE DEPENDENT CLAIM PRESENTED				x 130	$	OR	x 260	$
* If the difference in Col. 1 is less than zero, enter "0" in Col. 2				TOTAL	$	OR	TOTAL	$760

☑ Please charge Deposit Account No.**02-0393** in the amount of **$760.00** to cover the filing fee. The Commissioner is also hereby authorized to charge payment of the following fees associated with this communication or credit any overpayment to Deposit Account No. **02-0393**. A duplicate copy of this sheet is enclosed.

- ☑ Any additional filing fees required under 37 C.F.R. § 1.16.
- ☑ Any patent application processing fees under 37 C.F.R. § 1.17.

☐ A check to cover the filing fee is enclosed.

☑ The Commissioner is hereby authorized to charge payment of the following fees during the pendency of this application or credit any overpayment to Deposit Account No.**02-0393**. A duplicate copy of this sheet is enclosed.

- ☑ Any patent application processing fees under 37 C.F.R. § 1.17.
- ☐ The issue fee set in 37 C.F.R. § 1.18 at or before mailing of the Notice of Allowance, pursuant to 37 C.F.R. § 1.311(b).
- ☑ Any filing fees under 37 C.F.R. § 1.16 for presentation of extra claims.

Respectfully Submitted,

Date: March 19, 1999

Chris Kolefas (Reg. No. 35,226)
BAKER & McKENZIE
805 THIRD AVENUE
NEW YORK, N.Y. 10022

(212)751-5700

EXPRESS MAIL CERT. NO. EI827994554US
DATE OF DEPOSIT: March 19, 1999

SYSTEM FOR GENERATING OPTIMIZED COMPUTER DATA FIELD CONVERSION ROUTINES

FIELD OF THE INVENTION

The present invention is directed to computer data. More particularly, the present invention is directed to the conversion of one type of computer data field to another type.

BACKGROUND OF THE INVENTION

In many instances during computer processing of information, computer data must be converted from one data field type to another. For example, whenever data is passed from one program to another, the data typically goes though several conversions during the process, such as converting from text digits to a binary number.

EXPRESS MAIL LABEL NO. EI827994554US
DATE OF DEPOSIT: March 19, 1999

The typical technique for converting data includes using a generic data conversion routine. When an entire record of data must be converted, the conversion routine must determine what the characteristics or attributes are for each of the data fields in the record. This may require the conversion routine to execute the same decision tree for each field for each record even though each field has known characteristics that do not change on a row by row basis. Therefore, many computer cycles are wasted by asking questions such as "Is this field of type character, integer, etc.?" over and over for each data field.

Based on the foregoing, there is a need for a system that provides efficient conversion of data fields.

SUMMARY OF THE INVENTION

One embodiment of the present invention is a system for converting data from input field types to output field types. The system receives a plurality of input attributes and output attributes from an application program, dynamically generates a plurality of data field conversion routines for each set of input attributes and output attributes, and stores the plurality of data field conversion routines in memory that is accessible to the application program.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram that illustrates an overview of the functionality of an optimized conversion generator system in accordance with one embodiment of the present invention.

Fig. 2 is a flowchart of the steps performed by the system in accordance with one embodiment of the present invention to generate optimized conversion routines.

Fig. 3 is a flowchart of the steps executed by the application when using the routines to convert input fields to output fields.

Fig. 4 is a flowchart of the code generating steps executed the conversion generator system to generate code when called by the application.

Figs. 5a and 5b illustrate a general example of dynamic code building that is used in one embodiment of the present invention.

Figs. 6a - 6h illustrate a specific example of a dynamic code generation routine that performs CHARACTER to CHARACTER conversions.

DETAILED DESCRIPTION

One embodiment of the present invention is a system that generates optimized data field to data field conversion routines for each type of conversion required by an application program. Fig. 1 is a block diagram that illustrates an overview of the functionality of an optimized conversion generator system 20 in accordance with one

embodiment of the present invention. System 20 can be implemented in software and executed on a general purpose computer that includes a central processing unit, and memory. In one embodiment, system 20 is implemented with IBM/360 machine instructions.

An application program 10 requires one or more types of field conversions to be executed. For each type of conversion, application 10 provides to system 20 the input (or "source") and output (or "destination") field attributes. For each set of input and output field attributes, system 20 dynamically generates an optimized conversion routine 30 that performs the conversion. The optimized routines 30 are placed in storage that is available to application 10.

The routines 30 in one embodiment are generated as stand-alone routines that are capable of being serially reusable and are called by application 10 using, for example, an application program interface ("API") when a conversion is required. In another embodiment, the routines 30 are generated as code chunks that are inserted inline with application 10 and are directly accessed when a conversion is required.

One benefit of the present invention is that by building optimized conversion routines specifically tailored to the input and output field attributes, every execution of the routine saves numerous instructions that would normally be needed to identify field attributes each time the conversion is executed.

Fig. 2 is a flowchart of the steps performed by system 20 in accordance with one embodiment of the present invention to generate optimized conversion routines 30. The steps are executed by system 20 after application 10 determines at step 100 what attributes the input fields and output fields have.

At step 102, system 20 sets up the default process options of the generated conversion routines 30. The options may include whether the generated conversion routines 30 will be callable functions (i.e., able to be called by application 10), or copied inline into application 10. Step 102 builds a template interface block 104 which is an interface between application 10 and conversion generator system 20. Step 102 also generates an initiation call 106 that obtains the necessary storage and checks for errors.

At step 108, a loop is initiated. The loop continues until all fields that must be converted are exhausted.

Within the loop, at step 110 each set of input and output field attributes is received from application 10. The attributes are received through an API, and step 110 also builds a common field conversion interface block 116 based on the attributes.

At step 112, the code generator of system 20 is called, using the common interface block 116. Step 112 generates code 118.

At step 114, a function pointer that points to the generated field conversion routine 30 is saved.

Fig. 3 is a flowchart of the steps executed by application 10 when using routines 30 to convert input fields to output fields.

During step 122, the application is processing. At step 124, the application obtains source or input data to convert. Typically, step 124 involves reading one or more records.

At step 126, a loop is initiated for each record read. At step 128, in one embodiment the appropriate conversion routine 30 for the conversion is called.

When all the data field and records are converted, at step 132 the code generator system 20 is called for termination. This results in freeing up memory at step 134.

At step 136, application 10 continues to process. Finally, at step 138 application 10 is completed.

Fig. 4 is a flowchart of the code generating steps executed by conversion generator system 20 to generate code when called by application 10.

At step 200, system 20 initializes by, for example, establishing the required storage, checking for invalid options, and specifying how the code should be generated.

At step 202, system 20 validates specific field conversion options such as verifying that the input and output lengths are correct. Step 202 also determines how

big the code will be when generated. This can be used by application 10 if the generated code will be stored inline.

At step 204, system 20 builds the conversion routine using field conversion interface block 116.

At step 206, the storage obtained at step 200 is released.

Steps 202 and 204 go through the same internal process. Therefore, at step 208 the input field type is determined. Examples of input field types include character input 210 or special time format input 212. However, any input field type is supported by the present invention.

Similarly, at step 214 the output field type is determined. Examples of output field types also include character input 213 or special time format input 215, but any output field type is supported by the present invention.

At step 216, if step 202 was executed, the size of the generated code is determined. At step 218, if step 204 was executed, the field conversion routines 30 are generated.

As disclosed, system 20 in accordance with one embodiment of the present invention dynamically generates optimized conversion routines 30 for each set of input and output field attributes. Routines 30 are then utilized by application 10 to process conversions. Input and output fields are categorized into archetypal data types by system 20, each with definable attributes and conversion behaviors. For example:

- Character data types will be a fixed length field with a maximum length attribute and a CCSID (or character set code page) attribute.
- Date data types will be a fixed length field with a maximum length attribute and a format attribute (ISO, EUR, etc) which determines location and type of separators used in date.

Some previously described or additional features included in one embodiment of optimized conversion generator system 20 include:

- Optionally obtain and free storage for API control blocks and/or generated code.
- API control blocks can be chained and templated by API management functions.
- API control blocks can be built through use of a macro interface.
- Conversion routines can utilize registers to address the input and output field locations directly. The registers can be chosen by application 10 through API parameters.
- The source field address register may optionally be incremented to the end of the input field after conversion based on API parameters.
- The target field address register may optionally be incremented to the end of the formatted field after conversion based on API parameters.

- An additional register may be incremented by the length of the converted field based on API parameters.
- Standard Linkage may be generated for conversion routines based on API parameters.
- Conversion Error exits may be specified to handle enumerated conversion error conditions based on API parameters.
- Character Code Set translation conversion code can be generated based on API parameters (i.e., ASCII character fields can be translated to EBCDIC character fields).
- Conversion routines can be generated to utilize the latest instructions supported by the level of the operating system for which the code is being generated.

In one embodiment, system 20 dynamically generates code by building code chunks in storage accessible by calling application 10 based on various settings in the API control block. Generating the code involves the following steps, as discussed in conjunction with the flowcharts:

1. Obtain storage for the code.
2. Identify code templates needed.
3. Move code templates.
4. Modify code templates.

5. Return executable code to calling application.

Further, in one embodiment system 20 can optionally, based on the API specification, generate program debugging instrumentation for the dynamically generated code. This instrumentation can include an optional dynamically allocated output file containing, for each field conversion: a report of the API options used for each dynamically generated routine that can be used to insure correctness of field attributes and general processing options; and a disassembled listing of the dynamically generated routine provided by an internal disassembler within system 20 that can be used to identify conversion code inaccuracies and areas of further optimization, and to help resolve generated code failures.

Figs. 5a and 5b illustrate a general example of dynamic code building that is used in one embodiment of the present invention.

Figs. 6a - 6h illustrate a specific example of a dynamic code generation routine that performs CHARACTER to CHARACTER conversions.

Several embodiments of the present invention are specifically illustrated and/or described herein. However, it will be appreciated that modifications and variations of the present invention are covered by the above teachings and within the purview of the appended claims without departing from the spirit and intended scope of the invention.

WHAT IS CLAIMED IS:

1. A method of converting a plurality of input field types to a plurality of output field types by an application program, said method comprising:

(a) receiving a first attribute of a first input field type and a second attribute of a first output field type;

(b) generating a first optimized conversion routine based on said first attribute and said second attribute; and

(c) executing said first optimized conversion routine from said application program to convert said first input field type to said first output field type.

2. The method of claim 1, wherein step (c) comprises calling said first optimized conversion routine from said application.

3. The method of claim 1, wherein step (c) comprises storing said first optimized conversion routine inline with said application.

4. The method of claim 1, wherein step (b) is performed dynamically while said application program is executing.

5. The method of claim 1, further comprising:

(d) receiving a third attribute of a second input field type and a fourth attribute of a second output field type;

(e) generating a second optimized conversion routine based on said third attribute and said fourth attribute; and

(f) executing said second optimized conversion routine from said application program to convert said second input field type to said second output field type.

6. The method of claim 1, wherein said first and second attribute is character type.

7. The method of claim 1, further comprising generating program debugging instrumentation for said first optimized conversion routine.

8. A method of converting data from input field types to output field types, said method comprising:

(a) receiving a plurality of input attributes and output attributes from an application program;

(b) dynamically generating a plurality of data field conversion routines for each set of input attributes and output attributes; and

(c) storing said plurality of data field conversion routines in memory accessible to said application program.

9. The method of claim 8, wherein said data field conversion routines are callable by said application program.

10. The method of claim 8, wherein said data field conversion routines are stored inline said application program.

11. The method of claim 8, wherein step (b) is performed dynamically while said application program is executing.

12. The method of claim 8, wherein said input and output attributes are character type.

13. The method of claim 8, wherein said input and output attributes are date type.

14. The method of claim 8, further comprising generating program debugging instrumentation for said plurality of data field conversion routines.

15. A system for dynamically generating computer data field conversion routines, said system comprising:

a processor; and

a memory device coupled to said processor;

wherein said system is adapted to receive a plurality of input attributes and output attributes from an application program; and

wherein said memory device stores instructions that, when executed by said processor, cause said processor to:

dynamically generate a plurality of data field conversion routines for each set of input attributes and output attributes; and

store said plurality of data field conversion routines in a second memory device accessible to said application program.

16. The system of claim 15, wherein said data field conversion routines are callable by said application program.

17. The system of claim 15, wherein said data field conversion routines are stored inline said application program.

18. The system of claim 15, wherein said plurality of data field conversion routines are generated while said application program is executing.

19. The system of claim 15, wherein said input attributes are character type and said output attributes are date type.

20. The system of claim 15, wherein said processor further generates program debugging instrumentation for said plurality of data field conversion routines.

ABSTRACT OF THE DISCLOSURE

A system converts data from input field types to output field types. The system receives a plurality of input attributes and output attributes from an application program, dynamically generates a plurality of data field conversion routines for each set of input attributes and output attributes, and stores the plurality of data field conversion routines in memory that is accessible to the application program.

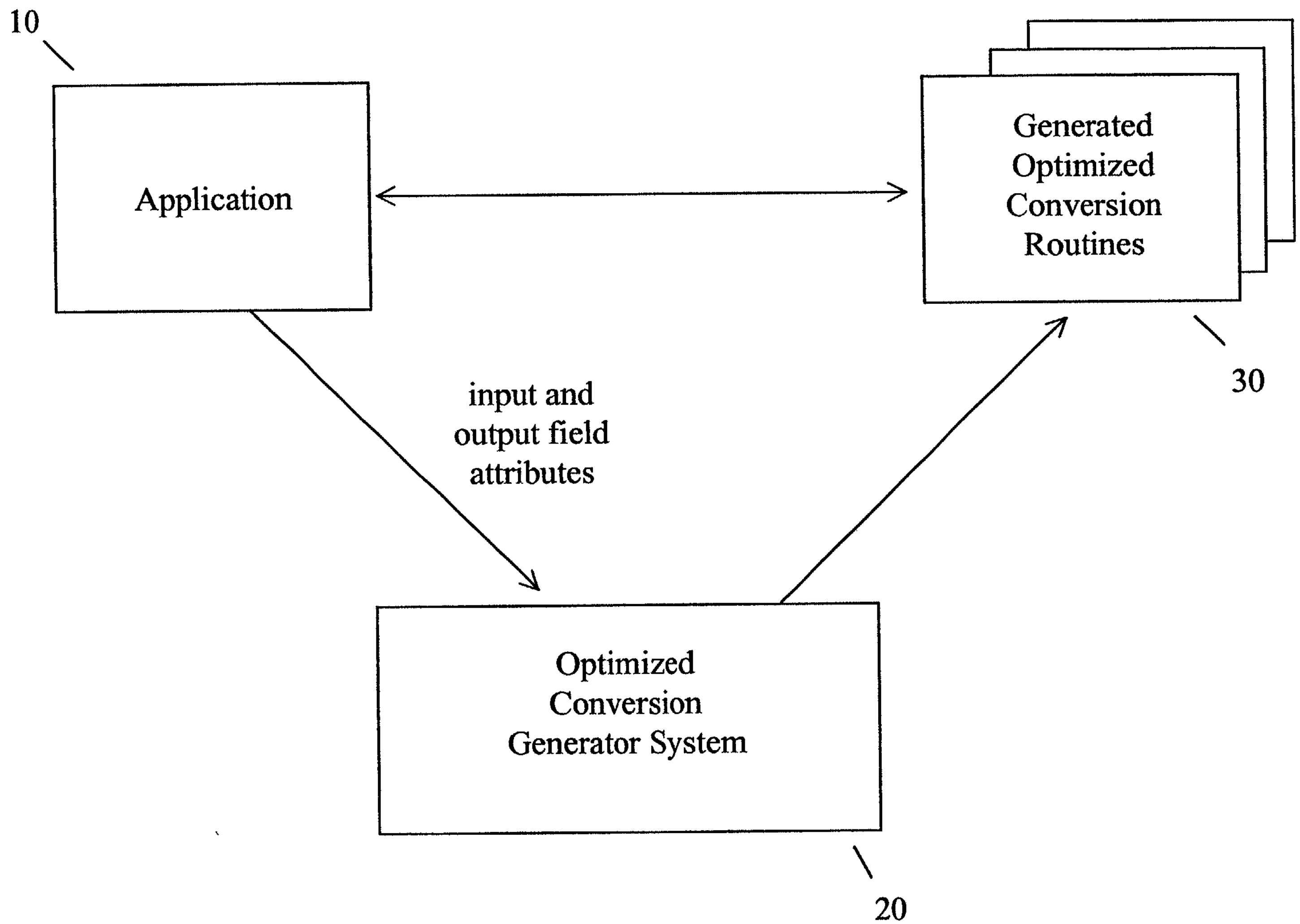
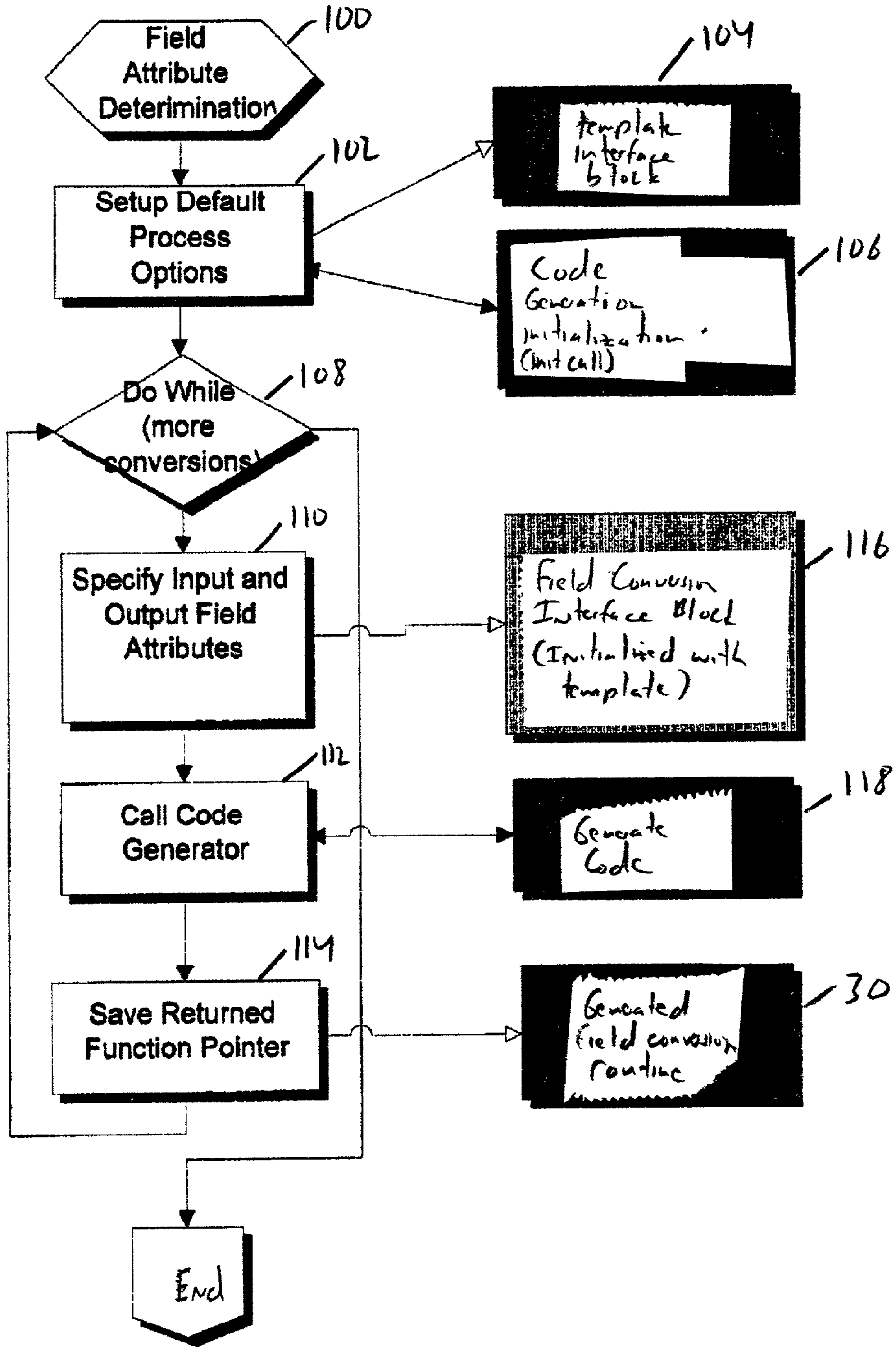

10
Application
Generated
Optimized
Conversion
Routines
30
input and
output field
attributes
Optimized
Conversion
Generator System
20

Fig. 1



Field Attribute Deterimination
100
Setup Default Process Options
102
template interface block
104
Code Generation initialization (init call)
106
Do While (more conversions)
108
Specify Input and Output Field Attributes
110
Field Conversion Interface Block (Initialized with template)
116
Call Code Generator
112
Generate Code
118
Save Returned Function Pointer
114
Generated field conversion routine
30
End

Fig. 2

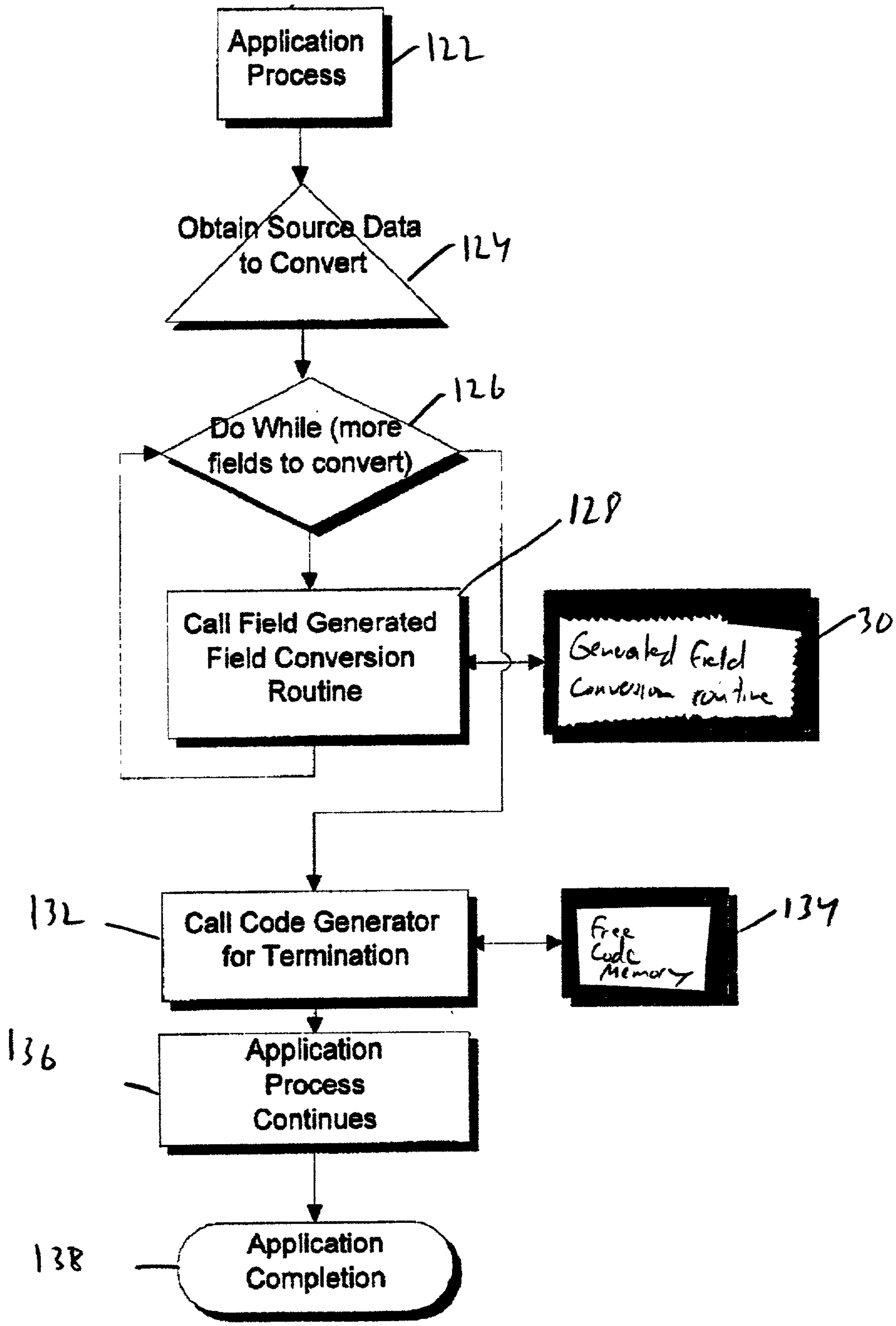

Application Process
122
Obtain Source Data to Convert
124
Do While (more fields to convert)
126
128
Call Field Generated Field Conversion Routine
Generated field conversion routine
30
132
Call Code Generator for Termination
Free Code Memory
134
136
Application Process Continues
138
Application Completion

Fig. 3

Code Generation Package

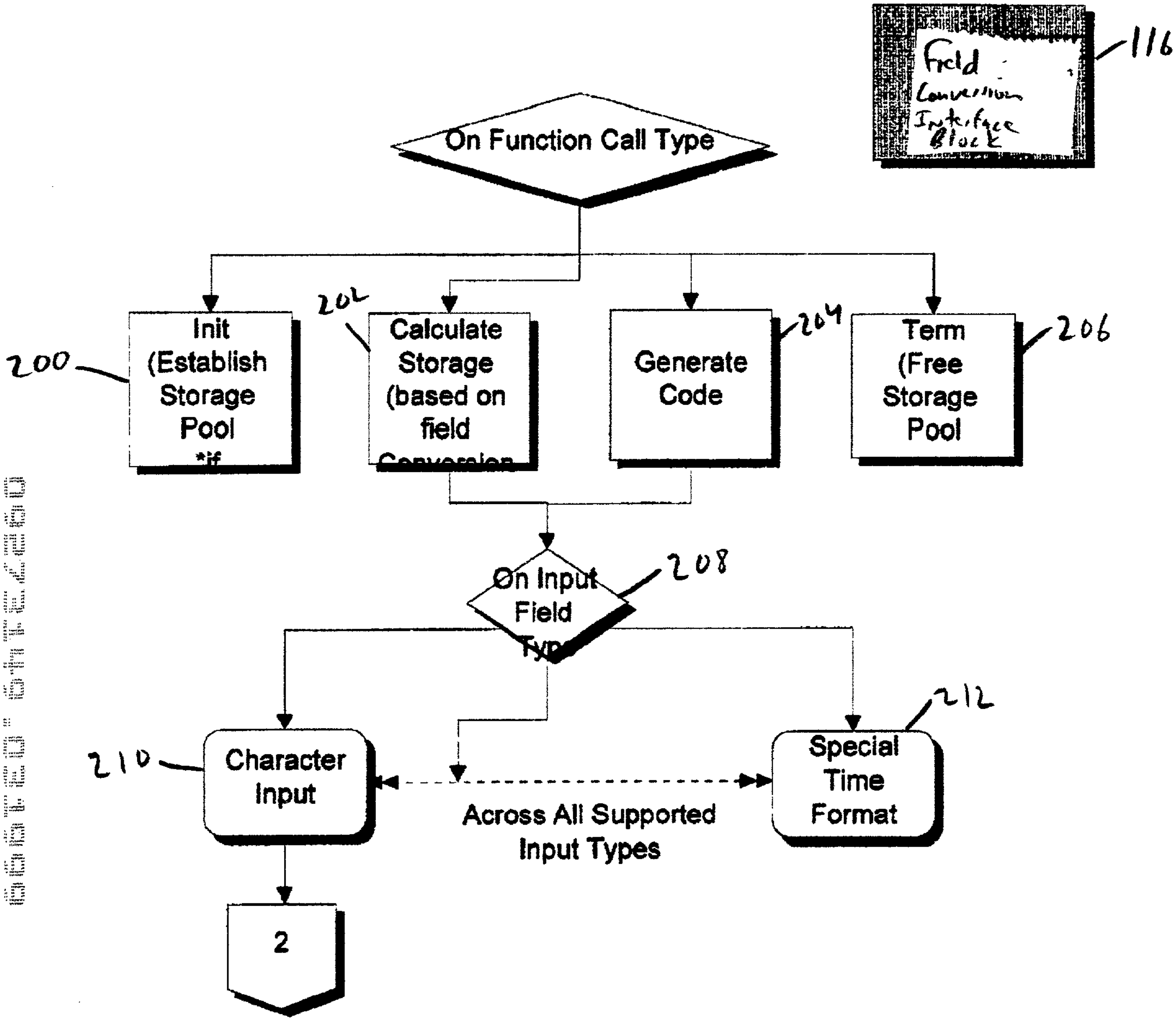
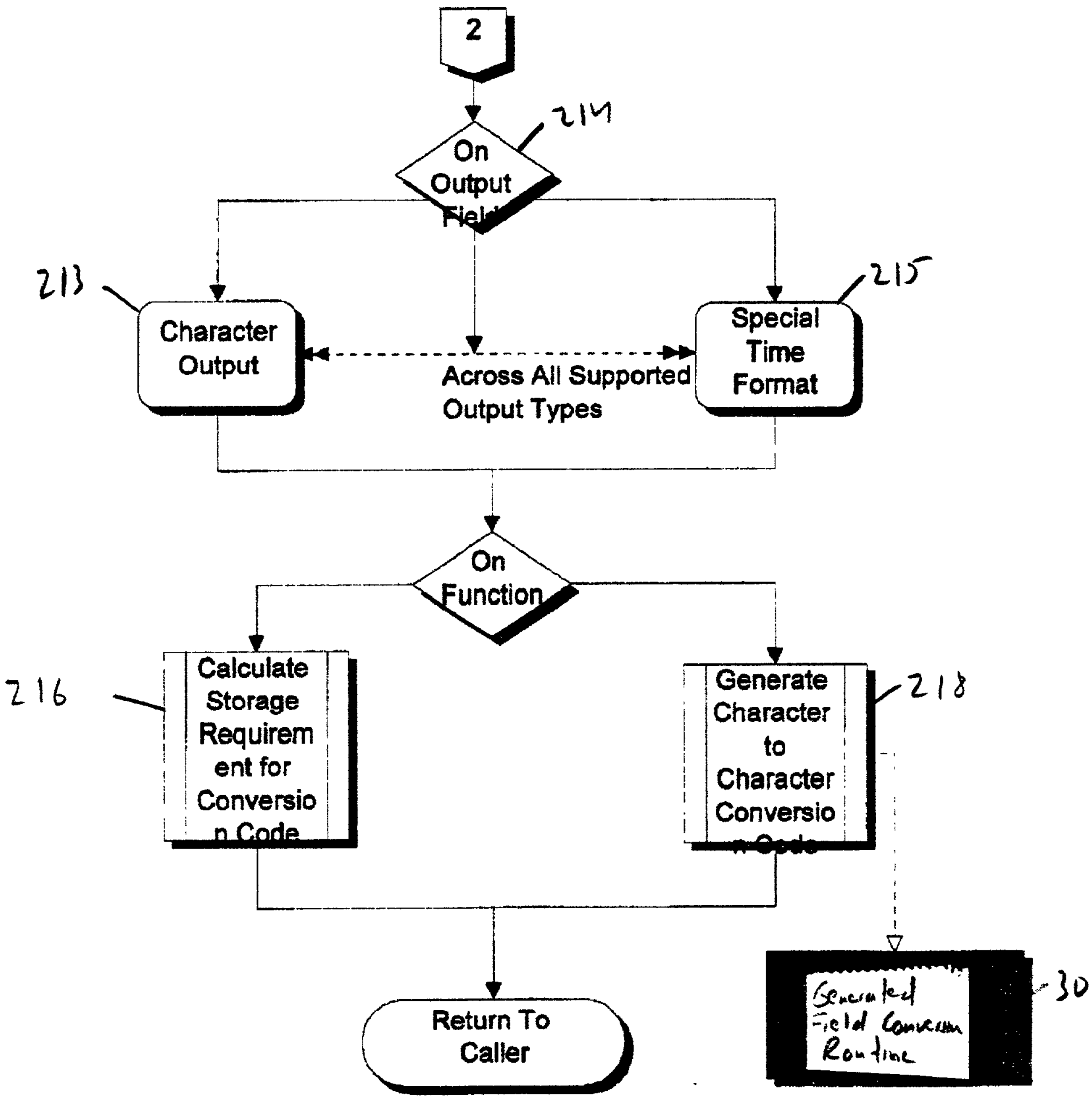


Fig. 4a



2
On Output Field
214
213
Character Output
Across All Supported Output Types
Special Time Format
215
On Function
216
Calculate Storage Requirement for Conversion Code
Generate Character to Character Conversion Code
218
Return To Caller
Generated Field Conversion Routine
30

Fig. 4b

```
R5     =     Current Instruction Offset within application buffer
R6     =     Current Instruction Address within application buffer
R7     =     Work Register - used for calculating offsets, etc
R12    =     Base register of code generator and template code

SLR          R5,R5                      clear offset
L            R6,$BCB_BCODE_@            get address of user buffer

* if linkage required call standard linkage builder
IF (TM,$BCB_PFLAG1,$BCB_LINKAGE,O)
   SETF    LINKAGE
   IF (CLI,$BCB_LINKAGE_TYPE,EQ,C'N')
      RESETF  LINKAGE
   COND ELSE
* call standard linkage builder
      #BAS    14,=A(BURST_ENTRY_LINKAGE)
   ENDIF
ELSE
   RESETF  LINKAGE
ENDIF
****
STDRETURN          -      RETURN TO APPLICATION
* $BCB_BCODE_@ WILL POINT TO BUILT CODE
****

*
* Routine to build standard entry linkage
*
BURST_ENTRY_LINKAGE CSMSUBI BASE=R10,WORKREG=R3
*
* Move Template code into user buffer
       MVC    0(STD_ENTL_010_L,R6),STD_ENTL_010
*
* Modify  " LA     R14,0(0)" instruction
* Get Offset to Savearea using equate STD_ENTL_010_SA_A
* Set base register for instruction to R12
* Set D(X,B) of instruction (R7 contains constructed D(X,B))
       LA     R7,STD_ENTL_010_SA_A(,R5)
       O      R7,=X'0000C000'
       STH    R7,STD_ENTL_010_SA_T(,R6)
*
```

Fig. 5a

```
* Modify  " B      0(R12)" instruction
* Get offset of branch target using equate STD_ENTL_010_B_A_T
* Set D(X,B) of instruction (R7 contains constructed D(X,B))
* ** Note X (index register) has been set by assembler as R12
*    STH does not change the instruction's index register
        LA     R7,STD_ENTL_010_B_A_T(,R5) CALC OFFSET FOR BRANCH TARGET
        STH    R7,STD_ENTL_010_B_A(,R6)   SET BRANCH D(X,B)
*
* Increment Next Instruction Offset (in R5) by length of code
* Increment Next Instruction Address (in R6) by length of code
        LA     R5,STD_ENTL_010_L(,R5)
        LA     R6,STD_ENTL_010_L(,R6)
*
* Return to caller
* Code has been built and the Instruction Offset and Address registers
* have been updated for next instruction construction

            CSMSUBO
*- STANDARD ENTRY LINKAGE ----------------------------------------------|
*                                                                      |
*----------------------------------------------------------------------|
STD_ENTL_010 DS  0S                                                    |
             STM    R14,R12,12(R13)                                    |
STD_ENTL_010_SA_T EQU  *-STD_ENTL_010+2                                |
             LA     R14,0(0)                BURSTED SAVEAREA+0         |
             ST     R13,4(,R14)                                        |
             ST     R14,8(,R13)                                        |
             LR     R13,R14                 R13 = BURSTED SAVEAREA     |
             LR     R12,R15                 SET BURSTED BASE REG       |
STD_ENTL_010_B_A  EQU  *-STD_ENTL_010+2                                |
             B      0(R12)                  WS_BRANCH                  |
STD_ENTL_010_SA_A EQU  *-STD_ENTL_010                                  |
             DC     18F'0'                                             |
STD_ENTL_010_B_A_T EQU  *-STD_ENTL_010                                 |
STD_ENTL_010_L   EQU   *-STD_ENTL_010                                  |
*----------------------------------------------------------------------|
```

Fig. 5b

```
* Call made by API passing API $BURSTCB control block
* Control block contains field attributes and conversion
* options

* Reset processing flags
*  NO_BUILD -> doing conversion routine storage calculation
*  CALLED_ROUTINE -> creating a called routine
* Check for API block -> if not there abend with dump
* Copy passed API block to working storage (IN_BCB)

MAIN_0000 DS      0S
*
          RESETF  NO_BUILD
          RESETF  CALLED_ROUTINE
*
          LTR     R1,R1
          BNZ     MAIN_0005
*
          ABEND   001,DUMP
*
MAIN_0005 DS      0S
          MVC     IN_BCB($BCB_LENGTH),0(R1)
*
          LA      R9,IN_BCB              R9 = ADDRESS OF $BURSTCB
          USING   $BURSTCB,R9
*
* If calculate storage requested SET NO_BUILD
          IF (CLC,$BCB_FUNC,EQ,=Y($BCB_CALC_STORAGE))
             SETF    NO_BUILD
          ENDIF

* INITIALIZE WORKING STORAGE
* If actually BUILDING code (not NO_BUILD)
*   1. Obtain offset from beginning of BASE REGISTER
*   for code.  If callable routine this has been set to 0.
*   otherwise this we are building inline code within the application's
*   user managed buffer and the offset will set to current instruction offset
*   within the buffer.
*    2. Obtain address of passed code buffer
*    3. Calculate current instruction address based on offset into buffer
```

Fig. 6a

```
MAIN_STRT DS      0S
         IF (¬NO_BUILD)
            LH       R5,$BCB_BCODE_OFFSET
            L        R6,$BCB_BCODE_@
            LA       R6,0(R5,R6)
         ELSE
            SLR      R5,R5                      CLEAR FOR ACCUM
            SLR      R6,R6                      CLEAR FOR ACCUM
         ENDIF
*
* INITIALIZE WORK FIELDS FOR ANY COLUMN CONVERSION
* 1. Obtain input field's addressing register
* 2. Build RX type assembler instruction D(X,B) with offset 0
* 3. Obtain output field's addressing register
* 4. Build RX type assembler instruction D(X,B) with offset 0
*    set template for output D(X,B)
* 5. Obtain input and output lengths
* 6. Set Current working D(X,B) templates
         SLR     R7,R7
         ICM     R7,B'0001',$BCB_IREG
         SLL     R7,4                                  SHIFT NIBBLE
         STC     R7,WB_INIT_SOURCE_DB
         ICM     R7,B'0001',$BCB_OREG
         SLL     R7,4                                  SHIFT NIBBLE
         STC     R7,WB_INIT_TARGET_DB
         MVC     WB_TOT_INPUT_LEN,$BCB_ILEN
         MVC     WB_TOT_OUTPUT_LEN,$BCB_OLEN
         MVC     WB_SOURCE_DB,WB_INIT_SOURCE_DB        RESET DB
         MVC     WB_TARGET_DB,WB_INIT_TARGET_DB        RESET DB
*
* CHECK FOR LINKAGE REQUIREMENTS
* IF LINKAGE = E (BASIC ENTRY - SAVE/RESTORE R14) THEN
*    BURST_WORK_BRANCH WILL SAVE R14 AND SET RESTORE_R14
*    BURST_EXIT_LINKAGE RESTORES R14 AND BASR R14
* ENDIF
         RESETF  RESTORE_R14
         IF (TM,$BCB_PFLAG1,$BCB_LINKAGE,O)
            SETF    LINKAGE
            IF (CLI,$BCB_LINKAGE_TYPE,EQ,C'N')
               RESETF  LINKAGE
            COND ELSE
               #BAS    14,=A(BURST_ENTRY_LINKAGE)
            ENDIF
         ELSE
            RESETF  LINKAGE
         ENDIF
```

Fig. 6b

```
* CALL INPUT TYPE PROCESSING ROUTINE
* 1. Get address of input field type table
*    This table contains an index of supported input types
*    with their associated code generation routines
* 2. Call code generation routine for Input field type
*    In this case INPUT FIELD TYPE IS CHARACTER
*    INPUT FIELD TYPE CHARACTER calls routine named CHARACTER
**** Further down subroutine CHARACTER is shown
         L        R14,=A(TYPE_TABLE)
         LH       R15,$BCB_ITYPE
         LA       R15,0(R14,R15)
         L        R15,0(,R15)
         BASR     R14,R15

* Subroutine has built conversion code for INPUT TYPE CHARACTER and OUTPUT TYPE CHARACTER
* Check for other process options such as: accumulate a source addressing register,
* accumulate a target addressing register, or accumulate alternate register.
* alternate register usually is a total output length accumulator used by the calling
* application to keep track of an aggregate of all output field lengths
* 1. IF source addressing register accumulate requested build code to accumulate
* 2. IF target addressing register accumulate requested build code to accumulate
* 3. IF length register accumulate requested build code to accumulate
* 4. IF exit linkage requested build exit linkage
* 5. RETURN TO API CALLER with generated conversion routine
MAIN_0200 DS      0S
         IF (TM,$BCB_PFLAG1,$BCB_SRC_ACUM,O)
            LH       R0,WB_SOURCE_ACCUM_INDEX
            IC       R1,$BCB_SRC_ACUM_REG
            LH       R7,WB_TOT_INPUT_LEN
            #BAS     14,=A(FIXED_ACCUM)
         ENDIF
*
         IF (TM,$BCB_PFLAG1,$BCB_TRG_ACUM,O)
            LH       R0,WB_TARGET_ACCUM_INDEX
            IC       R1,$BCB_TRG_ACUM_REG
            LH       R7,WB_TOT_OUTPUT_LEN
            #BAS     14,=A(FIXED_ACCUM)
         ENDIF
*
         IF (TM,$BCB_PFLAG1,$BCB_TRG_L_ACUM,O)
            LH       R0,WB_TARGET_ACCUM_INDEX
            IC       R1,$BCB_TLN_ACUM_REG
            LH       R7,WB_TOT_OUTPUT_LEN
            #BAS     14,=A(FIXED_ACCUM)
         ENDIF
*
* BURST EXIT LINKAGE
         IF (LINKAGE)
            SETF     CLEAR_R15
            #BAS     14,=A(BURST_EXIT_LINKAGE)
         ENDIF
         RETURN to CALLER
```

Fig. 6c

```
*-----------------------------------------------------------------*
* Character Input Field Type Conversion Routine                   *
* Abstract:                                                       *
*     This routine is called to either build Character Input      *
*     Fields to all supported Output Field Types, or to calculate *
*     storage requirements for generated conversion routines for  *
*     Input field type Character                                  *
*                                                                 *
* CHARACTER field type constraints                                *
*    These field types will be of fixed length                    *
*    Maximum length is 254 8bit bytes                             *
*    They may be proceeded with a null field indicator of length  *
*       1 byte that will contain values of x'00' for non-null fields *
*       and x'ff' for nulled fields.  Nulled fields will not be   *
*       converted accept to indicate on output that field was null *
*    There values are of EBCDIC CCSID (character code set) unless *
*    a CCSID is specified through the API.                        *
*                                                                 *
*-----------------------------------------------------------------*


CHARACTER CSMSUBI BASE=R10,WORKREG=R3
* Use branch table generated by API to branch on output type (BTYPE=O)
* Example is demonstrating character to character conversion
* Branch will be taken to CHAR_CHAR_0000
         L        R15,=A(RET_RC_32)
         $BURST   BTABLE,                                        X
               BREG=1,                                           X
               BTYPE=O,                                          X
               UNSUPPORTED=0(,R15),                              X
               CHAR=CHAR_CHAR_0000,                              X
               LVARC=CHAR_VARC_0000,                             X
               VARC=CHAR_VARC_0000

*-@PSEUDO-CODE@---------------------------------------------------
*                 CHARACTER TO CHARACTER CONVERSION
*
* -DETERMINE WORKING STORAGE
*   Some conversions require the generation of local working storage
*   Working storage is generated according to specific conversion options and
*   specific input and output field attributes to avoid generating more storage
*   than needed.
*
*   IF CONVERTING CCSID'S (character code sets) THEN
*     IF using a character translation table (uses TR instruction)
*       Build BRANCH over working storage
*       Build FULL WORD to hold Address character translation table
*       UPDATE Previously built Branch instruction to branch to current offset
*          (offset is next halfword aligned byte where next instruction is to be built)
*     ENDIF
*   ENDIF
*
```

Fig. 6d

```
*   IF INPUT LENGTH is GREATER than OUTPUT LENGTH
*      current implementation allows for truncation of trailing spaces
*      If input field being converted by generated code contains non-spaces
*         that won't fit into output field of lesser length then conversion
*         error 4 routine will be called to return a value of 4 in R15
*
*      1. Build BRANCH over working storage
*      2. Build a buffer full of spaces to be used in INPUT field compare
*      3. Build Conversion error routine to return error #4
*      4. UPDATE Previously built Branch instruction to branch to current offset
*          (offset is next halfword aligned byte where next instruction is to be built)
*    ENDIF
* - DETERMINE WORKING STORAGE
*
*-@PSEUDO-CODE@-------------------------------------------------------CHAR_CHAR_0000 DS 0S
*
* BURST WORKAREA IF CONVERSION ERROR OR CONVERT CCSID
          TM     $BCB_PFLAG2,$BCB_CCSID_CNV
          BNZ    CHAR_CHAR_0020
          CLC    $BCB_ILEN,$BCB_OLEN
          BNH    CHAR_CHAR_0040
*
CHAR_CHAR_0020 DS 0S
          #BAS   14,=A(BURST_WORK_BRANCH)
*
          IF (TM,$BCB_PFLAG2,$BCB_CCSID_CNV,NZ)
            IF (TM,$BCB_PFLAG2,$BCB_CCSID_CNV_ATOE,O)
               #BAS   14,=A(BURST_BWK_TO_E_XLATE_@)
            ELSE
               #BAS   14,=A(BURST_BWK_TO_O_XLATE_@)
            ENDIF
            #BAS   14,=A(BURST_BWK_FULL)
            STH    R7,WB_SAVE_R2_OFFSET
          ENDIF
*
* IF ILEN > OLEN THEN NEED FOLLOWING WORK FIELDS
*    BURST BUFFER255 - SPACES
*    BURST #@ERROR4 CALL
* ENDIF
          IF (CLC,$BCB_ILEN,GT,$BCB_OLEN)
             #BAS   14,=A(BURST_BWK_BUFFER255)
*
*
             LA     R1,4                            #@ERROR4
             #BAS   14,=A(BUILD_CNVERR)
          ENDIF
*
          #BAS   14,=A(UPDATE_WORK_BRANCH)
*
*
```

Fig. 6e

```
* IF OUTPUT NULLABLE THEN
*   BURST MOVEMENT OF NULL INDICATOR
*   R1 = X'00' FOR MVI Instruction Builder
*   WB_TARGET_DB (current target D(B)) USED FOR INDICATOR LOCATION
*   Build MVI OF NULL INDICATOR (MVI_0000)
*   UPDATE Current TARGET D(B) TO ALLOW DATA TO SKIP NULL INDICATOR
*   ADD 1 TO TOT OUTPUT LENGTH (FOR NULL INDC) (this allows for accumulation requests)
* ENDIF
CHAR_CHAR_0040 DS 0S
          IF (TM,$BCB_OFLAG1,$BCB_ONULL,O)
             SLR    R1,R1                        CLEAR SOURCE BYTE
             #BAS   14,=A(MVI_0000)              BURST MVI NULL INDC
*
             LH     R1,WB_TARGET_DB              UPDATE TARGET DB
             LA     R1,1(,R1)
             STH    R1,WB_TARGET_DB
*
             LH     R1,WB_TOT_OUTPUT_LEN         UPDATE OUTPUT LEN
             LA     R1,1(,R1)
             STH    R1,WB_TOT_OUTPUT_LEN
          ENDIF
*
*  IF input length < then output length
*     call routine to build code to pad output field with spaces
*  ELSE
*    IF input length = Output length
*      Call routine to build an MVC instruction
*          This routine uses current source and target D(B)'s
*           and the output length to construct the instruction
*    ELSE
*      input length > output length
*      Call routine to build an MVC instruction
*           This routine call will use the input length (since it shorter)
*           (source and target D(B)'s will be used
*       Build Code to check for truncation of only spaces
*    ENDIF
*  ENDIF
          LH     R1,$BCB_ILEN                 GET INPUT LEN
          LH     R2,$BCB_OLEN                 GET OUTPUT LEN
*
          CR     R1,R2                        CHECK LENGTHS
          BE     CHAR_CHAR_0050                  EQUAL
          BH     CHAR_CHAR_0100                  I > O ->
*
* INPUT LENGTH LESS THAN OUTPUT -> NEED TO PAD
* Build Character padding code
          #BAS   14,=A(SSP_0000)
*
* Build code TO MOVE CHARACTER FIELD TO CHARACTER FIELD
CHAR_CHAR_0050 DS     0S
          #BAS   14,=A(MVC_0000)              BURST MVC INSTRUCTION
          B      CHAR_CHAR_0200
*
```

Fig. 6f

```
* INPUT field is too large to fit
* Build code TO MOVE CHARACTER FIELD TO CHARACTER FIELD using input field's length
CHAR_CHAR_0100 DS     0S
          LR     R1,R2
          #BAS   14,=A(MVC_0000)                  BURST MVC INSTRUCTION
*
* MOVE CHECK FOR SPACES
* IF TRUNCATED DATA NOT SPACES THEN #@ERROR4

          IF (¬NO_BUILD)
*
          MVC    0(CHAR_CHAR_010_L,R6),CHAR_CHAR_010
*
* SET LENGTH OF COMPARE
          LH     R7,$BCB_ILEN
          SR     R7,R1
          BCTR   R7,0
          STC    R7,CHAR_CHAR_010_OLEN_A(,R6)
*
* SET SOURCE DB TO SOURCE + OLEN-1
          LH     R7,WB_SOURCE_DB
          LA     R7,0(R1,R7)
          BCTR   R7,0
          STH    R7,CHAR_CHAR_010_SDBN_A(,R6)
*
* UPDATE BUFFER OFFSET
          LH     R7,WB_BUFFER255_OFFSET
          O      R7,=X'0000C000'
          STH    R7,CHAR_CHAR_010_B255_A(,R6)
*
* UPDATE #@ERROR4 BRANCH
          LH     R7,WB_CNVERR4_OFFSET
          STH    R7,CHAR_CHAR_010_BERR_A(,R6)
*
          ENDIF              (NO_BUILD)
*
          LA     R5,CHAR_CHAR_010_L(,R5)
          LA     R6,CHAR_CHAR_010_L(,R6)
*
```

Fig. 6g

```
* CHECK FOR TRANSLATION of CCSID's
* If translation requested call translation routine generator
*   *** note translation routine will perform accumulation
*       operation if API requested it.  If accumulation is performed
*       by the routine the IN_BCB (copy of API block used by generator)
*       will be updated to turn off accumulation by the main process
*       done upon CHARACTER subroutine (see above)
CHAR_CHAR_0200 DS      0S
              IF (TM,$BCB_PFLAG2,$BCB_CCSID_CNV,NZ)
*                  IF IREG =2 AND SRC_ACCUM TR INST WILL BUMP REG
                  SETF   SAVE_R2
                  IF (CLC,$BCB_IREG,EQ,=H'2'),AND,                     X
                 (TM,$BCB_PFLAG1,$BCB_TRG_ACUM+$BCB_TRG_L_ACUM,NZ)
                     RESETF SAVE_R2
                     NI      $BCB_PFLAG1,X'FF'-$BCB_SRC_ACUM
                  ENDIF
                  RESETF XLATE_TO_E
                  IF (TM,$BCB_PFLAG2,$BCB_CCSID_CNV_ATOE,0)
                     SETF XLATE_TO_E
                  ENDIF
                  #BAS    14,=A(DO_XTAB_SHORT)
              ENDIF
*
CHAR_9999 DS      0S
          B       CHARACTER_END
*----------------------------------------------------------------------|
* BURST CHARACTER TO CHARACTER ILEN > OLEN                             |
* TEMPLATE CODE USED FOR NON-SPACE TRUNCATION                          |
*----------------------------------------------------------------------|
CHAR_CHAR_010 DS 0S                                                    |
CHAR_CHAR_010_OLEN_A EQU *-CHAR_CHAR_010+1   LEN OF CLC                |
CHAR_CHAR_010_SDBN_A EQU *-CHAR_CHAR_010+2   LOC OF SOURCE TO COMP     |
CHAR_CHAR_010_B255_A EQU *-CHAR_CHAR_010+4   LOC OF 255 SPACES         |
         CLC    0(0,0),0(0)                  SDB+(OLEN-1),BWK_BUFF255  |
CHAR_CHAR_010_BERR_A EQU *-CHAR_CHAR_010+2                             |
         BNE    0(R12)                       NOT SPACES? -> #@ERROR4   |
CHAR_CHAR_010_L   EQU *-CHAR_CHAR_010                                  |
*----------------------------------------------------------------------|
```

Fig. 6h

[22074661-25541]

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am an original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled **SYSTEM FOR GENERATING OPTIMIZED COMPUTER DATA FIELD CONVERSION ROUNTINES**, the specification of which is filed herewith.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application(s) for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN APPLICATION(S)

Number	Country filed	Day/month/year	Priority Claimed Under 35 USC § 119

I hereby claim the benefit under Title 35, United States Code, §§ 119(e) of any United States provisional application(s) listed below:

PRIOR PROVISIONAL APPLICATION(S)

Application Number	Filing Date

[NYC] 251988.1

EXPRESS MAIL LABEL NO. EI827994554US
DATE OF DEPOSIT: March 19, 1999

I hereby claim the benefit under Title 35, United States Code § 120, of any United States application(s) listed below or under § 365(c) of any PCT international application(s) designating the United States of America listed below, and insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application(s) in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

PARENT APPLICATION(S)

U.S. Parent or PCT Parent Application Number	Parent Filing Date	Parent Patent Number (if applicable)

And I hereby appoint James David Jacobs (Reg. No. 24,299), Jonathan S. Caplan (Reg. No. 38,094), Chris Kolefas (Reg. No. 35,226), Victor DeVito (Reg. No. 36,325) and Harry K. Ahn (Reg. No. 40,243) my attorneys with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.